Landing an Autonomous Vehicle on a Moving Target

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Abstract

This project involves autonomous aerial vehicle navigation and landing on a moving platform. The goal of the project is to have an autonomous hexacopter take off from an autonomous surface vehicle that is in constant movement, collect data and transmit that data to a ground station before returning to the surface vehicle. This entails a communication link between the ground station, the surface vehicle and the hexacopter for autonomous synchronized navigation. Operationally, the concept requires a way for the hexacopter to land on the moving surface vehicle, requiring a 2-axis stabilized platform. The platform and the task of landing on a moving target are both handled by on-board processors independent from the autopilots which are fed with sensor information from the landing platform and aerial vehicle. Upon completion of the project, a scientist would be able to collect data over land or water with a completely autonomous system capable of multiple takeoffs and landings while operating continuously in the mission area.

Introduction

Real time data collection over a large area is traditionally done using relatively expensive techniques such as flying a long range unmanned aerial vehicle. The goal of this research effort is to design an inexpensive and efficient system for collecting data over a set area. To do this, an aerial vehicle and surface vehicle will be used together to collect the data. The aerial vehicle will carry the data collection payload and the surface vehicle will act as a mobile launch site. The purpose for using these vehicles together for the data collection is to reduce the cost of data collection and to possibly have a self sustaining system. Aerial vehicles that are capable of being part of an inexpensive self-sustaining system would have a limited range, which is why it is necessary to use a surface vehicle as a staging area.

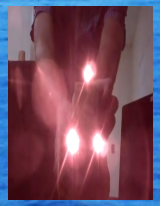
Approach

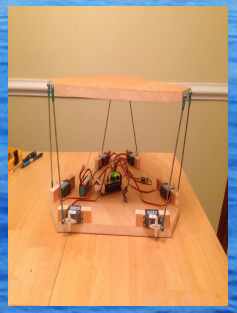
USV

- The unmanned surface vehicle (USV) will be a small catamaran that has a stabilized horizontal platform mounted on the bow of the ship. The platform will have three infrared LEDs mounted in the shape of an isosceles triangle to be detected by the aerial vehicle's infrared camera.

UAV

- The unmanned aerial vehicle (UAV) will be a hexacopter. A dedicated processing board will run a program that takes live video from a downward facing infrared camera and use an image processing library to determine the UAV's position in relation to the platform on the surface vehicle. Then, the program will apply a custom algorithm to derive the velocity vector that will maintain the UAV's position over the platform. Once the velocity vector is calculated, the program sends RC input commands to the UAV's autopilot.





Conclusion

The project was an overall success. Throughout the course of the internship, the goals set in the approach were fulfilled. The stabilized landing platform was constructed and the algorithm for maintaining roll and pitch was derived based on the fundamental math of the platform design. The unmanned aerial vehicle was constructed and a method for landing on a moving target was designed. A proof-of-concept simulation was designed which successfully tested the image processing technique. The work done throughout the internship has proven one approach to landing on a moving target without human intervention and the basic design can be scaled up to larger implementations.

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